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A newly established round goby (*Neogobius melanostomus*) population in the upper stretch of the river Elbe

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ABSTRACT

Key-words: *Gobiidae, species introduction, non-native species, population expansion, ship-mediated transport*

The invasive round goby (*Neogobius melanostomus*, Pallas, 1814) has increased its European range dramatically over recent decades, with international shipping suspected as the main vector. Here, we provide the first population and morphological data for a newly established round goby population in the upper Elbe (Ústí nad Labem, Czech Republic). Surveys in 2013 along the same stretch found no evidence of gobies, indicating introduction within the past two years. Analysis of morphological similarity confirms the most likely source as the recently established population in the tidal Elbe near the port of Hamburg. Due to the species' restricted range (<15 km; with density localised on Ústí nad Labem port), distance from proposed source (600 km; no reports from the intervening stretch) and the speed with which this distance was crossed (less than three years), we suggest port-to-port transfer as the most likely vector route. Our data highlight the speed with which this species has been able to colonise most watersheds in Europe *via* establishment of widely-separated populations through port-to-port transfer and rapid inter-site connection through downstream drift and natural migration.

RÉSUMÉ

La population de gobie à taches noires nouvellement implantée (*Neogobius melanostomus*) dans un bief amont du fleuve Elbe

Mots-clés : *Gobiidae, introduction d'espèce, espèce non indigène, expansion de population,*

Le gobie à taches noires invasif (*Neogobius melanostomus*, Pallas, 1814) a augmenté son aire de répartition européenne de façon spectaculaire au cours des dernières décennies, le transport maritime international étant soupçonné d'être le principal vecteur. Ici, nous fournissons les premières données populationnelles et morphologiques sur ce gobie à taches noires nouvellement implanté dans l'Elbe supérieure (Ústí nad Labem, République tchèque). Des sondages en 2013 le long du même tronçon n'ont trouvé aucune preuve de gobies, impliquant que l'introduction date des deux dernières années. L'analyse de similitude morphologique confirme que la source la plus probable de la population récemment établie est dans l'estuaire de l'Elbe près du port de Hambourg. En raison de l'extension

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transfert par bateau

locale restreinte de l'espèce (<15 km ; avec la densité localisée près du port Ústí nad Labem), et de la distance de la source proposée (600 km, pas de données sur le tronçon intermédiaire) et la rapidité avec laquelle cette distance a été franchie (moins de trois ans), nous suggérons un transfert de port à port comme vecteur de transport le plus probable. Nos données mettent en évidence la rapidité avec laquelle cette espèce a été capable de coloniser la plupart des bassins hydrographiques en Europe par la création de populations largement séparées par le transfert de port à port et la connexion rapide inter-site par la dérive vers l'aval et la migration naturelle.

INTRODUCTION

The round goby (*Neogobius melanostomus*, Pallas, 1814) is one of a number of Ponto-Caspian Gobiids that have expanded their ranges over recent decades (see review in Roche *et al.*, 2013). A native of the Black, Caspian and Azov Seas and their tributaries (Miller, 2004), the species became established in several major European watersheds around the 1990s, including those of the Danube (Jurajda *et al.*, 2005; Painter and Seifert, 2006; Wiesner, 2005), Rhine (Borcherding *et al.*, 2011; Kalchhauser *et al.*, 2013; Van Beek, 2006) and the Vistula and Oder (Grabowska *et al.*, 2010). They have even been introduced into the Laurentian Great Lakes of North America (Jude *et al.*, 1992). It is now generally accepted that initial introductions have been through international shipping at major ports (Wiesner, 2005) through accidental transport of juveniles/eggs in ballast water or as eggs attached to the ship's hull (Ahnelt *et al.*, 1998; Hayden and Miner 2009), followed by natural spreading from the point(s) of introduction (Roche *et al.*, 2013). Movement may also be assisted through introduction by anglers as bait or by transport of eggs/juveniles on equipment (Kornis *et al.*, 2012). In this way, widely separated introduction points have quickly been joined and large stretches of navigable river colonised. This has been supported in many cases by the ubiquitous presence of rip-rap banks, a preferred habitat of this species (Jurajda *et al.*, 2005; Ray and Corkum, 2001), along Europe's navigable rivers. Natural colonisation, *e.g.* along non-navigable tributaries, tends to be slower (Schomaker and Wolter, 2014). The round goby has also been introduced into brackish and marine waters in Europe; indeed, the first reported introduction outside of its native area was into the Gulf of Gdansk (Southern Baltic Sea) in 1990 (Skóra and Stolarski, 1993). Since then, they have spread along the Baltic Sea coast (Michalek *et al.*, 2012; Sapota and Skóra, 2005), with the western dispersal route reaching the coastal waters of the Jutland peninsula. Further expansion of this branch, together with eastward spread through canals connecting North Sea Basin rivers (Brunken *et al.*, 2012; van Beek, 2006), was the probable source of round goby colonisation of the lower River Elbe (Hempel and Thiel, 2013).

Round gobies were first reported on the River Elbe on the tidal stretch at Hamburg (Germany; 53°31′28″N, 9°59′11″E; Figure 1) in 2008, having been caught by a commercial fisherman (Hempel and Thiel, 2013). Between 2011 and 2013, the species was being caught relatively frequently by anglers around Hamburg. Despite the presence of a large weir separating the freshwater upstream Elbe and the tidally influenced Elbe "estuary", one specimen has been caught further upstream, near the town of Geesthacht (53°43′58″N, 10°37′79″E; r. km 936), 34 km southeast of Hamburg in 2012 (Hempel and Thiel, 2013). No fish have been reported above this point to date.

On the 4th August 2015, a round goby was caught for the first time in the upper Elbe at Svádov (Czech Republic), near the city of Ústí nad Labem (50°39′38″N, 14°031′56″E; Figure 1), 603 r. km upstream of Geesthacht, during an ecotoxicological examination by the Czech Angling Union (T. Kava, Czech Angling Union, Pers. Comm.). Up to that date, there had been no report of gobies above Geesthacht. On the 17th August, a fish was accidentally caught during sampling of zoobenthos (Buřič *et al.*, 2015) and a further individual was reported by an angler close to the previous site (village of Povrly; 50°40′23.3″N, 14°09′38.3″E)

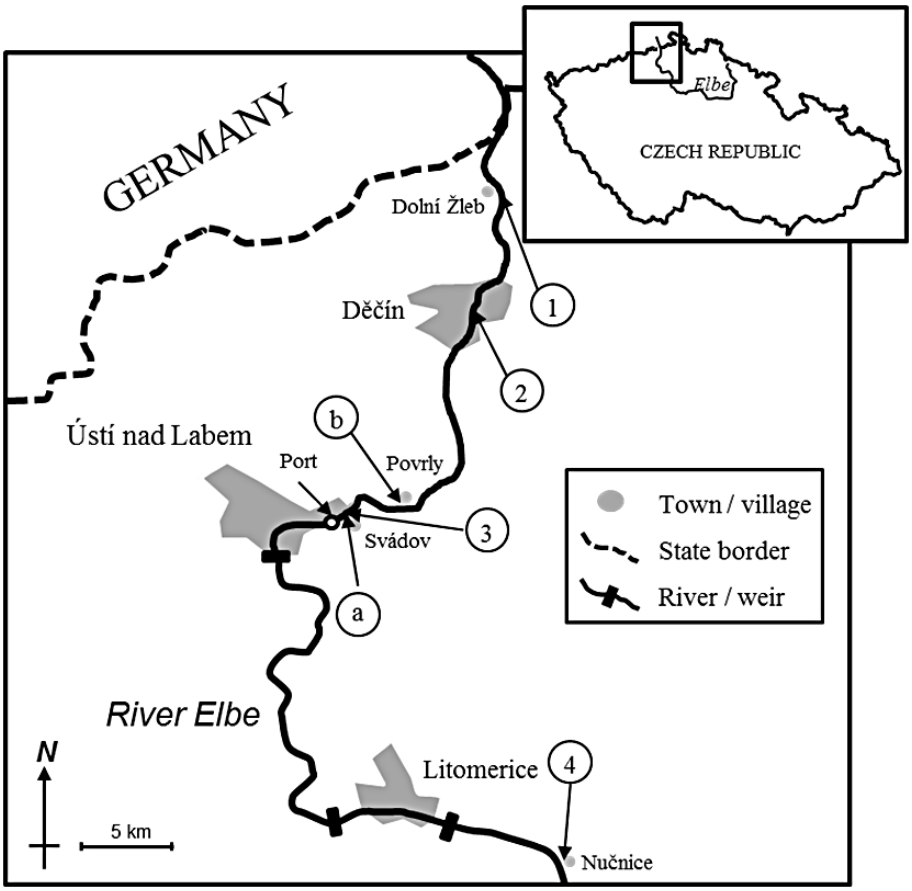

Figure 1
Map of the upper Elbe illustrating: a) first finding of round goby (4.8.2015), b) second individual caught (20.8.2015), 1) the Dolní Žleb sampling site, 2) the Děčín sampling site, 3) the Svádov sampling site, and 4) the Nučnice sampling site (1-4 all 26.8.2015); see Table I for coordinates.

on the 20th August (Skalický *in litt.*). Very soon after (see below), while undertaking mandatory ichthyological monitoring of the upper Elbe under the EU Water Framework Directive, members of the Institute of Vertebrate Biology, Czech Academy of Sciences, caught multiple specimens at several locations along the river. An identical survey by the Academy and the Angling Union in 2013 (Jurajda *et al.*, 2013; unpublished report) found no goby presence along the same stretch, suggesting introduction sometime within the last two years.
Here, we provide the first data on population characteristics (size, sex ratio, proportion of juveniles) for this new population, along with morphometric measurements and a discussion on the possible source of the population. In addition, we provide data on the native ichthyofauna, thus providing background data for assessing any future impact of this non-native species on local fish populations.

METHODS

Fish sampling was conducted at four sites on the River Elbe between Dolní Žleb (5 km upstream of the Czech/German border) and Nučnice on the 26th August 2015 (Figure 1; see Table I for coordinates). The riverbank throughout this stretch has been modified and stabilised with 10–50 cm stony rip-rap. The river bottom in the section from Dolní Žleb to Svádov has a natural stony substrate and, during periods of very low discharge (as during this sampling period), some parts of the bank consist of sand-gravel beaches. Aquatic vegetation was absent throughout the stretch. The Nučnice site lies above a weir and water flow is much

reduced. As a result, the river bottom is covered with mud and nearshore aquatic vegetation is commonly present.

Fish were caught along the river bank (depth not exceeding 80 cm, mean sampled width ca. 1.2 m) during the day using single pass continual electrofishing (SEN battery-powered backpack electrofishing gear, Bednář, Czech Republic) fitted with a 2 mm mesh anode, with 100 m of shoreline generally being sampled. Details on the actual sampling methods used are described in more detail in Polačik *et al.* (2008). All fish sampled (native and non-native) were identified and measured, native species being immediately returned alive to the water. Fish data are presented as relative percentage and estimated total density (fish·m^{-2}) at each site (Table I).

All round gobies were sacrificed with an overdose of clove oil then placed in ice for transport to the laboratory. In the laboratory, the fish were measured to the nearest 0.01 mm using digital callipers, weighed to the nearest 0.01 g (total weight) and fin clips taken and stored in 96% ethanol for further genetic analysis. Sex was determined during fish dissection based on the type of gonads present and on external genitalia. Fish with absent or indistinguishable gonads were considered as juveniles and those with clearly distinguishable gonads as adults. The proportion of each sex (juveniles excluded) was used to calculate the adult sex-ratio.

Table I
Geographic characteristics (GPS coordinates and river km) and fish assemblage structure (relative %) for the four sites monitored on the upper Elbe on 26th August 2015.

Site		Dolní Žleb	Děčín	Svádov	Nučnice
River km		363	353	333	295
Coordinates N		50°50′33.14″	50°46′53.66″	50°39′57.27″	50°30′23.66″
Coordinates E		14°13′04.16″	14°12′26.30″	14°06′00.83″	14°13′33.72″
Common name	Scientific name				
Roach	*Rutilus rutilus*	21.6	7.4	27.6	24.4
Dace	*Leuciscus leuciscus*	1.1	5.5		
Chub	*Leuciscus cephalus*	55.7	25.2	17.2	45.3
Ide	*Leuciscus idus*		2.5	3.0	2.9
Nase	*Chondrostoma nasus*	3.4	6.7		
Gudgeon	*Gobio gobio*		4.9	10.4	12.2
White-fin gudgeon	*Gobio albipinnatus*	1.1	1.2	1.5	
Stone morocco	*Pseudorasbora parva*			0.7	
Barbel	*Barbus barbus*	13.6	21.5	17.9	
Bleak	*Alburnus alburnus*		2.5		0.6
Vimba	*Vimba vimba*				4.7
Bitterling	*Rhodeus amarus*				8.1
Goldfish	*Carassius auratus*				0.6
Stone loach	*Barbatula barbatula*		1.8		
Wells	*Silurus glanis*				0.6
Three-spined stickleback	*Gasterosteus aculeatus*				
Perch	*Perca fluviatilis*	1.1	11.0	7.5	0.6
Ruffe	*Gymnocephalus cernuus*	2.3	6.1	6.7	
European bullhead	*Cottus gobio*		0.6	0.7	
Round goby	*Neogobius melanostomus*		3.1	6.7	
Total density (fish·m^{-2})		44.0	81.5	167.5	172.0

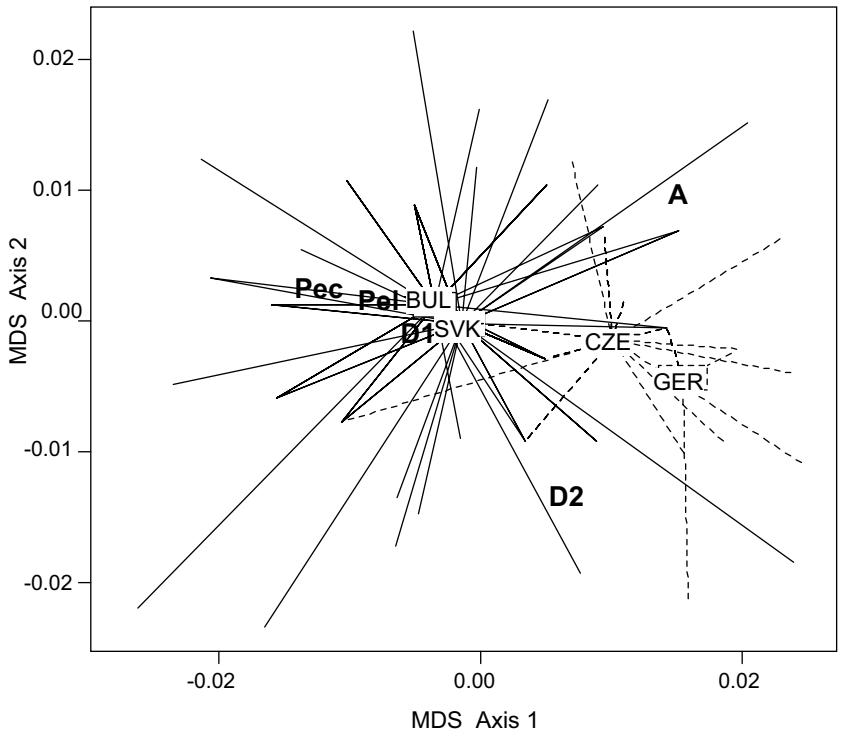

Figure 2
MDS ordination showing similarities in meristic characteristics (in bold) of four round goby populations. Number of fin rays: Pec = pectoral, Pel = pelvic, D1 = 1st dorsal, D2 = 2nd dorsal, A = anal. Populations: BUL = Bulgarian Danube, SVK = Slovakian Danube, CZE = Czech Elbe, GER = German Elbe.

Morphological characteristics (data presented in Supplementary Table I) were compared with those originating from the tidal Elbe (data obtained from Hempel and Thiel, 2013) and non-native and native Danubian populations from Slovakia and Bulgaria, respectively (described in Polačik *et al.*, 2012). Only meristic characteristics were taken into account due to allometric growth in round gobies (L'avrinčíková *et al.*, 2005) and a mismatch in fish length between populations. Multiple analysis of variance (MANOVA) and multidimensional scaling were used to compare and visualise the meristic characters, using the R statistical software, version 3.2.1 (R Core Team, 2015).

RESULTS

Round goby were present at both Svádov (r. km 333) and Děčín (r. km 353) but not at Dolní Žleb (r. km 363) or Nučnice (r. km 295) (see Figure 1; Table I). Fourteen fish were caught at Svádov (equivalent to 0.11 fish·m^{-2}) and five at Děčín (equivalent to 0.03 fish·m^{-2}). At both positive sites, native species were present in high abundance, with gobies representing a minor part of the assemblage (Table I).

All five gobies caught at Děčín were $<$46 mm SL, presumably representing young-of-the-year fish. On the other hand, most gobies sampled at Svádov (13 ind.) had fully-developed gonads and were classed as adults. Most of these fish were between 40 and 65 mm SL, with one individual measuring 78 mm SL and one 102 mm SL (in the absence of further aging evidence (*e.g.* scale readings), we estimate that these correspond with 1+, 2+ and 3+ fish, respectively). The overall male:female sex ratio at Svádov was 1.83:1.

There was no significant difference in meristic characteristics between round gobies from the tidal Elbe and the upper Elbe (MANOVA, $P = 0.24$; Figure 2). There was, however, a significant difference between both Elbe populations and the two Danubian populations (MANOVA, all $P < 0.001$; Figure 2).

DISCUSSION

In this study, the detection of a newly established round goby population far from any source population provides compelling new evidence supporting the rapid spread of round gobies in European river networks through port-to-port transfer by shipping. Several lines of evidence strongly suggest that the upper Elbe population originated through boat-mediated transport from the port at Hamburg on the tidal Elbe.

Both the upper and lower Elbe populations share statistically similar morphological (meristic) characteristics. While such evidence could be considered indirect as a) meristic characteristics are not fully heritable (Hermida *et al.*, 2002) and (b) morphological characteristics can change significantly due to environmental factors within just a few weeks (Olsson and Eklöv, 2005; Heerman *et al.*, 2007), it is certainly compelling. The morphological analysis also discredits the possibility that the fish originated from within the Czech Republic through overland transport (*e.g.* in an anglers bait bucket) from the Rivers Morava and Dyje, until now the only established round goby population in the Republic. The Morava/Dyje population, which originated through natural migration up the Morava from the Danube, should share morphological characteristics with Danubian gobies, which in turn display distinct morphological differences to those on both the upper and lower Elbe. Moreover, despite being closer geographically (290 km), gobies have no possibility of migrating naturally between the Morava/Dyje and Elbe as they are situated in different watersheds, unconnected by any artificial canal.

Secondly, the rate of spread appears too fast for natural dispersal to have taken place (*i.e.* by swimming). As we are unaware of any further surveys reporting goby occurrence upstream of Geesthacht since the single observation in 2012, gobies would have to have swum 600 km upstream in just three years. This is far beyond the rate of natural upstream migration observed in recent studies (estimates range from 1–15 km per year; see Marentette *et al.*, 2011; Lynch and Mensinger, 2012; Janáč *et al.*, 2012).

Finally, the upper Elbe population appears to be restricted to the area immediately surrounding the inland port at Ústí nad Labem, which lies approximately 1.5 km upstream of Svádov. Our data suggest that gobies have not yet penetrated Střekov weir, 4 km upstream of the port (first weir on the Elbe upstream of Geesthacht), as no gobies were found at Nučnice. Furthermore, no gobies were caught 30 km downstream of the port at Dolní Žleb. The five fish found at Děčín (20 km downstream of the port) were all juveniles and, while it is possible that they represent new arrivals, it is more probable that they colonised the site as drifting early life-stages from the near-port stretch (see Janáč *et al.*, 2013). Děčín, therefore, in addition to representing the furthest downstream extent of the population also provides evidence of reproduction and expansion from an upstream site. This same pattern of restricted distribution near ports has also been observed in other isolated round goby 'populations' (*e.g.* Vienna/Bratislava; Roche *et al.*, 2013).

Thus far, the upper Elbe round goby population represents a minor part of the local fish assemblage (note, however that local fishermen have reported high densities around the port itself [not sampled during our survey]; T. Kava, pers. comm.). Based on previous experience, it is highly likely that gobies will come to dominate the local fish assemblage, as they have elsewhere (see Kornis *et al.*, 2012). Furthermore, as drift of early life-stages has been shown to greatly increase the rate at which gobies spread downstream (Janáč *et al.*, 2012), colonisation of the German stretch of the Elbe, with eventual connection with the downstream tidal population, would appear inevitable. Upstream migration is likely to be much slower, in part due to the presence of multiple weirs along this upper stretch.

Previous studies, and particularly those from the Laurentian Great Lakes, have reported round gobies directly affecting native fish assemblages through predation of eggs and juveniles (Chotkowski and Marsden, 1999; Roseman *et al.*, 2006), competition for shelter and spawning interference (Janssen and Jude, 2001; Balshine *et al.*, 2005; Bergstrom and Mensinger, 2009). To date, however, none of these has been confirmed as having a major impact in European rivers (Vašek *et al.*, 2014; Všetičková *et al.*, 2015; Janáč, unpublished data). Instead, we suspect that round gobies will affect the native fish assemblage through effects on other ecosystem components, *e.g.* by providing a reservoir for native parasites (*i.e.* the

spill-back effect; Ondračková *et al.*, 2015), strongly impacting local invertebrate communities (Lederer *et al.*, 2008; Kipp and Ricciardi, 2012) and through incorporation into food-webs (Rush *et al.*, 2012; Polačik *et al.*, 2015), with subsequent alterations to food-web structure and energy and pollutant transfer (Rogers *et al.*, 2014).

This newly established population highlights the speed with which this species has been able to colonise wide areas of Europe via establishment of widely-separated populations through port-to-port transfer and rapid inter-site connection through downstream drift and natural migration. Its recent establishment and presently isolated status provides an ideal opportunity for long-term monitoring in order to assess rates of colonisation and actual impacts on recipient ecosystems.

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Supplementary Table I. Morphological characteristics for round gobies sampled from the upper stretch of the River Elbe.

Characteristics / individual no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Site	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov	Svádov
Total length	55.63	66.85	70.63	91.30	71.36	66.19	74.50	66.11	67.7	54.82	72.36	46.67	67.55
Standard length	47.86	56.06	59.74	78.77	61.08	56.22	64.02	55.92	55.8	45.97	60.75	38.62	57.29
Total weight	2.67	3.75	4.34	11.48	4.57	3.50	4.72	3.63	3.64	1.80	4.95	1.07	3.90
First dorsal fin spines	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI
Second dorsal fin spines and rays	I,16	I;14	I;15	I;14	I;15	I;15	I;15	I;15	I;15	I;14	I;15	I;15	I;14
Anal fin spines and rays	I,12	I;12	I;12	I;11	I;11	I;12	I;12	I;12	I;12	I;11	I;13	I;11	I;12
Pelvic fin spines and rays	II,10	II;10	II;9	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10
Pectoral fin rays	18	18	18	18	18	19	18	19	20	18	18	18 (+1)	18 (+1)
Sex	M	M	F	M	F	F	F	M	M	M	M	JUV	F
Body depth	10.50	11.85	12.18	13.87	10.77	10.42	10.91	9.65	11.27	8.78	11.96	6.91	11.05
Head length	14.24	16.22	16.56	21.24	17.27	16.19	17.99	16.81	16.60	12.39	17.60	10.30	17.02
Head depth	9.28	10.27	11.33	15.31	10.81	10.44	11.85	10.97	11.17	7.78	10.80	6.57	10.52
Head width	8.81	11.73	11.55	16.48	11.16	10.99	11.32	11.01	10.93	8.10	12.45	6.95	11.34
Snout length	3.48	4.93	5.27	7.06	6.02	4.88	5.80	5.21	4.62	3.85	4.99	2.93	5.04
Postorbital head length	6.98	8.11	8.83	10.31	9.23	7.76	9.51	8.81	8.32	5.59	8.57	4.55	8.15
Orbit diameter	2.50	3.71	3.76	5.09	3.96	3.95	4.14	3.36	3.55	3.20	3.85	2.61	3.64
Interorbital width	1.58	3.48	2.07	4.23	2.29	2.17	2.32	1.92	1.77	1.17	2.09	0.66	1.57
Caudal peduncle depth	5.86	6.99	6.83	10.31	6.81	6.02	7.15	6.81	7.30	5.11	6.86	4.54	6.22
Caudal peduncle length	10.63	11.07	12.47	15.57	11.16	10.55	14.17	10.93	10.65	8.83	11.24	7.04	10.66
Pre-pectoral length	12.86	16.93	18.91	19.98	17.95	15.17	18.30	16.89	17.72	14.19	19.08	12.22	17.94
Pre-pelvic length	14.19	17.25	18.29	22.08	19.15	16.83	18.94	16.52	17.84	13.79	19.83	12.2	18.71
Pre-dorsal length	16.49	19.05	20.54	26.03	20.81	19.90	21.32	19.08	18.82	14.87	21.42	13.54	19.94
Pre-anal length	28.31	32.48	31.67	45.22	33.86	31.34	35.87	31.13	30.35	25.57	32.67	22.33	32.41
First dorsal fin height	6.20	8.06	7.37	10.79	8.93	8.22	9.08	8.01	6.48	6.00	8.03	4.68	6.97
Pectoral fin length	11.36	13.78	15.16	20.24	17.20	16.97	16.10	15.19	13.58	11.30	13.75	9.73	14.39
Pelvic fin length	8.79	12.20	12.08	16.67	13.47	12.18	12.59	11.25	11.04	9.13	11.71	8.05	11.26
Pelvic fin insertion to anal fin origin	15.63	16.86	17.75	20.64	16.04	15.82	18.93	15.05	14.33	11.8	15.79	10.75	15.23

Supplementary Table I. Continued.

Characteristics / individual no.	14	15	16	17	18	19	20	21	22	23	24
Site	Svádov	Svádov	Svádov	Svádov	Svádov	Děčín	Děčín	Děčín	Děčín	Děčín	Svádov*
Total length	60.37	56.90	120.44	76.76	55.45	48.56	50.20	55.03	51.09	40.86	95.43
Standard length	49.50	47.25	102.77	63.81	47.96	40.99	43.04	45.36	42.17	33.82	81.30
Total weight	2.47	2.00	21.10	5.54	2.04	1.53	1.51	1.61	1.52	0.74	13.52
First dorsal fin spines	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI
Second dorsal fin spines and rays	I;16	I;16	I;15	I;15	I;14	I;14	I;15	I;15	I;14	I;14	I;15
Anal fin spines and rays	I;12	I;12	I;11	I;12	I;11	I;11	I;112	I;12	I;10	I;12	I;12
Pelvic fin spines and rays	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10	II;10
Pectoral fin rays	19	17	18	19	17	17	17	18	18	18	18
Sex	M	M	F	M	M	JUV	JUV	JUV	JUV	JUV	F
Body depth	9.02	9.21	19.52	12.75	8.73	7.79	7.86	7.77	7.42	5.81	19.27
Head length	12.89	13.38	28.46	19.94	13.00	11.47	11.97	12.25	10.96	9.50	21.10
Head depth	8.29	8.58	20.58	12.02	8.27	8.07	6.59	7.78	7.13	5.17	16.69
Head width	9.67	8.34	23.26	12.66	8.27	7.60	7.62	7.61	7.48	6.01	19.21
Snout length	4.28	3.68	10.25	5.92	3.81	3.01	4.01	4.07	3.27	2.78	7.29
Postorbital head length	6.50	6.41	14.23	9.31	6.43	5.90	2.54	5.80	4.82	4.70	11.19
Orbit diameter	3.35	3.34	6.04	3.47	2.67	2.90	2.97	3.02	3.05	2.37	5.08
Interorbital width	1.62	1.49	4.44	2.65	1.25	1.44	1.50	1.16	1.14	0.41	3.82
Caudal peduncle depth	5.76	5.34	12.48	7.59	5.02	4.87	4.80	4.90	5.17	3.70	10.26
Caudal peduncle length	9.52	9.56	20.93	11.71	9.12	7.24	10.14	7.64	7.21	6.23	16.48
Pre-pectoral length	15.08	14.06	30.06	17.31	13.21	12.61	11.82	14.49	13.56	10.50	20.65
Pre-pelvic length	15.41	15.28	32.75	220.07	14.73	12.29	12.45	14.03	13.79	10.30	22.39
Pre-dorsal length	16.85	16.62	35.11	20.98	16.32	14.96	14.50	14.45	14.59	11.78	26.22
Pre-anal length	26.09	27.26	58.57	36.31	26.06	23.79	23.09	25.54	24.50	17.95	45.87
First dorsal fin height	5.58	6.14	12.20	8.81	5.52	5.74	5.19	5.70	5.26	4.37	10.54
Pectoral fin length	11.92	10.82	28.20	16.41	14.05	10.90	11.80	10.54	10.33	7.94	21.54
Pelvic fin length	10.36	8.67	19.02	13.02	10.36	9.35	9.72	9.13	9.18	7.01	16.15
Pelvic fin insertion to anal fin origin	14.70	13.98	31.56	16.80	15.05	12.25	13.16	12.12	11.99	8.06	22.11

*First specimen captured on the river.